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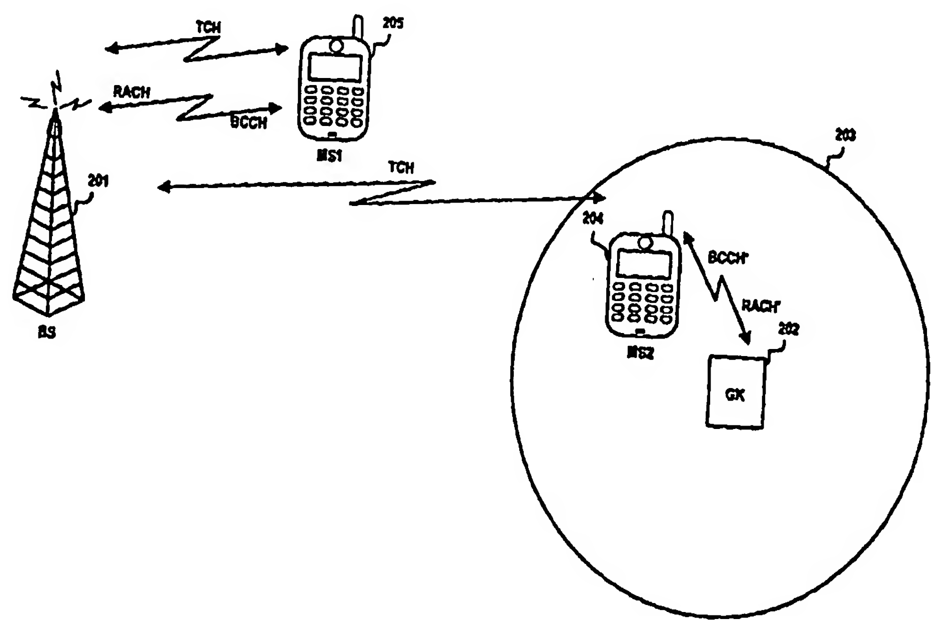

(57) Abstract

A proxy base station (202) is disclosed. The proxy base station (202) receives a valid network broadcast channel, modifies various information elements thereof and retransmits the modified channel to mobile stations (MS2) in a defined area (203). Uplink transmissions of mobile stations (MS2) are treated similarly. Further means for network management, capturing and using information provided through the invention are discloses.

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Method and system for providing location specific services to mobile stations

FIELD OF THE INVENTION

The present invention relates generally to mobile telephone systems. More particularly, the present invention relates to a method for providing location specific services to mobile stations.

BACKGROUND OF THE INVENTION

The anticipated convergence between the worlds of Internet and wireless personal communications requires more accurate location of mobile users on the go. Various methods are being utilized in order to locate mobile stations (MS) within the serving area of the mobile telephone network.

The most widely implemented location method extracts the cell ID, which is registered in any given moment as the serving base station of a given mobile station. Mobile networks keep track of their subscribers' location at any given time. The Global System for Mobiles (GSM), which is a widely accepted system, uses a process called location update (LU) for mobile stations to inform the network of their whereabouts. An MS performs LU on several occasions such as when it moves from one location area to another. A location area is defined as a group of base stations defined by the network to be part of a given location area, each of them transmitting the same location area identity code (LAI). Mobile stations also perform LU periodically in accordance with the definition broadcast on the control channel by the network.

By monitoring and logging the location updates carried out by mobile stations, the network can provide external applications highly usable information to enable location specific services. This way, the application can determine that a given subscriber is located within the serving area of a certain cell site. It is also possible

to monitor and log the exact antenna sector, by which the location update has been received, thereby enhancing the location accuracy.

GSM handsets supporting the SIM Application Toolkit standard (STK), may run local applications on the Subscriber Identity Module (SIM), which is triggered by a change of location area.

Various other positioning technologies enable network operators to locate their mobile users more accurately than cell site resolution. Most location systems require either additional infrastructure on the network side or modified mobile stations. Location technologies based exclusively on additional equipment on the network side are typically based on signal Time of Arrival (TOA) or Angle of Arrival (AOA). Network based solutions apply to all existing handsets but require large investments in additional infrastructure. Other technologies require modification or replacement of handsets in order to support location functions. These include solutions based on the Global Positioning System (GPS) and Enhanced Observed Time Difference (E-OTD). Handset modification is a lengthy and costly process for network operators.

Moreover, most of the location technologies mentioned above perform poorly indoors due to physical constraints and cannot reliably determine the exact location of a mobile station when inside a given indoor environment. Some applications require conclusive knowledge whether or not the subscriber is inside a given place or not. The inability of prior art technology to provide such accurate pinpoint positioning renders some applications commercially unviable.

The present invention discloses a cost-effective method for determining the location of mobile stations when located within defined locations thereby enabling the provision of location specific services.

SUMMARY OF THE INVENTION

The present invention provides a method and system for providing location specific services for mobile stations. The disclosed method and system is a proxy base station that relays signals coming to/from the network side through a proxy device with respect to a defined location. The proxy device may alter any of the signals exchanged between the mobile stations and the network.

In accordance with one embodiment of the present invention certain modifications are applied to signals exchanged between the network and mobile stations, thereby enabling accurate location of said mobile stations.

In accordance with another embodiment of the present invention, by monitoring and logging the messages exchanged between locally monitored mobile stations and the network, various services may be offered based on said messages.

BRIEF DESCRIPTION OF THE DRAWINGS

Some embodiments of the present invention will be better understood and some of its numerous objects and advantages will become more apparent to those skilled in the art by reference to the following drawings, in conjunction with the accompanying specification, in which:

FIG. 1 is an illustrative diagram describing a typical cellular system composed of 7 cell sites, each having a base station incorporating a transceiver.

FIG. 2 is a functional diagram illustrating the system of the present invention as part of the mobile telephone network.

FIG. 3 is a block diagram illustrating the various components of the present invention.

FIG. 4 is a functional diagram illustrating a hierarchical scheme of location service area within another one.

DETAILED DESCRIPTION

FIG. 1 illustrates a basic cellular system having 7 hexagonal cells numbered 1-7. Cell 7 is shown in the center, surrounded by adjacent cells 1-6. The serving area of a mobile telephone system would typically contain more than 7 cells, however, for ease

of reference, only 7 cells are shown in FIG. 1. Each cell 1-7 contains a base station including a transmitter, receiver and base station controller as are well known in the art. The base station transmitter/receiver is connected to an antenna tower 11-17 which is used to transmit signals to, and receive signals from, mobile telephones, within the mobile telephone system serving area. In FIG. 1 the base stations antenna towers 11-17 are selected to be located at the center of each of the cells 1-7, respectively and are equipped with Omni-directional antennas. However, in other configurations of a cellular radio system, the base station towers 11-17 may be located near the periphery, or otherwise away from the center of the cells 1-7 and may illuminate the cells 1-7 with radio signals either Omni-directionally or directionally. Therefore, the representation of the cellular radio system of FIG. 1 is for purposes of illustration only and is not intended as a limitation on the possible implementations of a mobile radio communications system within which an indoor position is defined for the purpose of locating subscribers and providing location oriented services. A regulated area 10 is located within cell 7, and a plurality of mobile stations being used across the entire serving area within cells 1-7. Again, only one defined location is shown in FIG. 1, but it should be understood that the actual number of defined locations may be larger, in practice.

Referring now to FIG.2, within the serving area of a given base station 201 a typical defined location is defined by installing the system of the present invention

202. The transmission of device 202 is calibrated so as to effectively cover the area around it 203. Calibration may include transmission power and directional antenna. Within the serving area of base station 201 various mobile stations are being served in accordance with the frequency allocation of said base station. Whereas the broadcast control channel (BCCH) transmitted by base station 201 is received as the strongest channel by all mobile stations within said geographical area, mobile stations typically camp on said BCCH channel while in idle mode. Mobile stations that require the establishment of communications with the network do so on the reverse access channel (RACH) corresponding to the said BCCH. Upon typical establishment of communication with the network, a dedicated channel is assigned to the mobile station. Said dedicated channel may be a traffic channel (TCH) or a dedicated control channel (SDCCH).

In one embodiment of the present invention, device 202 transmits a local BCCH' channel, which is a modified version of the BCCH transmitted by base station 201. Mobile station 204, which is located within area 203, receives BCCH' as the strongest serving broadcast channel and therefore camp on it. Other mobile stations such as MS 205, which are located outside the coverage area of device 202, will regularly camp on the original BCCH transmitted from base station 201. Mobile station 204, while camping on channel BCCH', will access the network by transmitting on channel RACH', which is the reverse duplex channel of BCCH'. In the representative embodiment, channel BCCH' typically contains all the information transmitted by the network on the original BCCH channel, except modified information elements. Device 202 may alter, replace, modify, monitor and log each and every message exchanged between mobile station 204 and the network. It should be understood that the term BCCH refers to all logical channels mapped onto the physical channel containing BCCH information. Such physical channel may contain the BCCH, CCCH, SDCCH and SACCH (as defined in ETSI Technical Specification GSM 05.02). Upon initiating or receiving a call, the network assigns a traffic channel (TCH) on which the conversation is to be held. Since mobile station 204 camps on channel BCCH', which contains the same

channel assignment information as in the original BCCH, mobile station will be assigned with a traffic channel that will allow direct communication with base station 201, which is the serving cell in that area. Device 202 may incorporate means for maintaining mobile station synchronization with the network as result of the time difference between the signals originating from base station 201 and those transmitted by device 202.

In one embodiment of the present invention, the BCCH' channel transmitted by device 202 contains a different location area identifier (LAI) than the LAI transmitted on the original BCCH. Upon the entry of mobile station 204 into coverage area 203 where channel BCCH' is the strongest broadcast channel, MS 204 will initiate a location update procedure with the network through the RACH'. Device 202 receives the location update request (LUR) originated by mobile station 204 and retransmits it on the original network RACH. The LUR may be modified by device 202 in order to make sure that the forced LUR appears to the network as a regular periodic location update.

In another embodiment of the present invention, channel BCCH' may include the same LAI transmitted on the original BCCH channel, however the timer value for periodic location updating (e.g., T3212) may be modified so as to trigger a location update before the expiry of the timer value broadcast on the original BCCH transmitted by the network.

While camped on BCCH', mobile station 204 performs neighboring cell measurements and maintains a list of neighbor cells and their received signal strength measurements (BA list). The BA list maintained by mobile station 204 includes the original BCCH as one of the strongest neighboring cells. Device 204 may optionally transmit another phantom BCCH (PH-BCCH) with a unique base station identity code (BSIC). Upon entering into dedicated mode for the purpose of location update, mobile station 204 reports the measured BA list to the network. By analyzing the contents of the BA list, the network is able to determine

that mobile station 204 is located within area 203. The disclosed method and system uses the network signaling in order to achieve accurate location of mobile stations. There is no need for any additional reporting method in order to update the network with respect to mobile stations location.

It should be understood that although the BCCH' channel transmitted by device 202 typically uses an RF channel different than the one used by the original BCCH channel transmitted by the network. in cases where the isolation between the signals is sufficient, they may actually share the same frequency.

The invention demonstrates a clear advantage over prior-art location techniques by introducing the concept of relative logical location. In many applications, it is sufficient to determine that mobile users are located within a certain contextual environment (e.g., mobile stations are inside a theater of a given cinema chain). It may be irrelevant to know which exact cinema hall or even address but extremely important to know that the mobile station is located inside the theater and not in the street outside of it.

FIG. 3 is a typical block diagram illustrating one embodiment of device 202. Referring now to FIG. 3, base station 301 transmits its broadcast information on BCCH, which is received by antenna 303 and fed into RX module 304. The entire device is controlled by micro-controller 302. RX module decodes the contents of the physical channel on which BCCH is transmitted and transfers a bit stream to real-time processor (RTP) 305. RTP 305 effectuates any required modification of the BCCH bit stream (e.g., a new LAI or timer T3212 value) and transfers the modified bit stream to TX module 306. TX module 306 transmits the modified bit stream on channel BCCH' via antenna 307. Mobile station 308 camps on channel BCCH' and accesses the network via channel RACH', which is received by RX module 310 through antenna 309. RTP 311 processes the bit stream output of RX module 310 and modifies it, if required (e.g., old LAI, unique network measurement result reporting). TX module 312 retransmits the modified RACH'

information on the original network RACH through antenna 313. MS 315 is used to provide network management features to the device by connecting it to micro-controller 302. The latter may communicate with the network via SMS and receive neighbor cell measurements from MS 315. Phantom BCCH generator 316 optionally generates a dummy BCCH channel having a unique BSIC that is transmitted by TX module 317 via antenna 318 on channel PH-BCCH. Micro-controller 302 determines the transmission power of PH-BCCH so as to be included in the BA list measured by mobile station 308. Alternatively, RTP 311 may modify the network measurement reports of mobile stations so as to incorporate a uniquely identifiable combination of measurement results that will notify the network where the location update came from (e.g., location device ID number).

In yet another embodiment of the present invention, real-time processor 305 may also modify the bit stream of the original network BCCH and replace the original network broadcast with a locally generated short messaging cell broadcast message (SMS-CB). Mobile stations entering the coverage area of device 202 will display locally generated SMS cell broadcast messages. Such messages may also be used for triggering STK applications on mobile stations located therein.

In still another embodiment of the present invention, real-time processor 305 may include and external interface that enables monitoring of exchanged messages by an external host application.

Device 202 referred to in FIG. 2 may be combined with a repeater device in order to improve radio coverage within the coverage area thereof. Repeater devices are often used within indoors locations where mobile radio coverage is sometimes insufficient. When installing a repeater device, the entire downlink frequency band is received, amplified and retransmitted indoors. The uplink frequency band is received within the indoor location and retransmitted outside. The combination of the location device with a coverage enhancement repeater reduces the overall cost

of manufacturing and installation. thereby increasing the overall value from said combined repeater/location device.

The present invention also enables to form a hierarchy of location service areas whereby a small location area is defined within a larger one. FIG. 4 illustrates an area covered by base station 401. Within said area, a location device 402 illuminates area 403 wherein another location device 404 illuminates location area 405, which is defined within location area 403. The illustrated system tracks mobile station 406 while moving between the different coverage areas.

In another embodiment, a cellular base-station signaling device transmits a local BCCH channel having system information of the real network, however with a different LAI. Said signaling channel is received as the strongest serving cell within a given area. Upon entry of mobile stations into said area, a location update is attempted on the RACH corresponding to the said locally generated BCCH. The signaling device receives the location update request and returns a rejection message. Upon receiving the reject message, the mobile station performs cell reselection procedure and camps on the next suitable cell. The signaling device reports back to the network or to a dedicated location server the identity of the mobile station attempting to register.

Claims:

1. A proxy base station comprising:

Means for receiving a valid network downlink channel comprising control information and conversion thereof into bit stream; and

Means for real-time processing of said downlink bit stream to enable modification of said bit stream; and

Means for retransmission of modified bit stream over a locally generated channel within a given area; and

Means for receiving an uplink channel used by mobile stations within said given area and conversion thereof into bit stream; and

Means for real-time processing of said uplink bit stream to enable modification thereof; and

Means for retransmission of said modified uplink bit stream on the network uplink channel.

2. The system of claim 1, further comprising means for wireless remote network management.

3. The system of claim 1, further comprising means for generating a phantom cellular broadcast channel and transmission thereof.

4. The system of claim 1, wherein said locally generated downlink channel includes a modified Location Area Information.

5. The system of claim 1, wherein said locally generated downlink channel includes a modified timer value for periodic location update.

6. The system of claim 1, wherein said locally generated downlink channel includes a locally generated SMS cell broadcast messages.

7. The system of claim 1, further comprising means for maintaining local mobile station synchronization to network.

8. The system of claim 1, wherein said modification of uplink channel includes altered network measurement reporting.

9. The system of claim 1, further comprising a coverage enhancement repeater device.

10. The system of claim 1, further comprising means for monitoring network messages respective to transmissions on said modified uplink channel for determination of mobile stations location.

11. The system of claim 1, wherein said locally generated downlink and uplink channels are transmitted on the same RF channels used by the network.

12. The system of claim 1, further comprising means for external monitoring and logging of messages exchanged between the network and mobile stations.

13. A method of using the system of claim 1 in a hierarchical manner wherein a smaller location service is defined within a larger one.

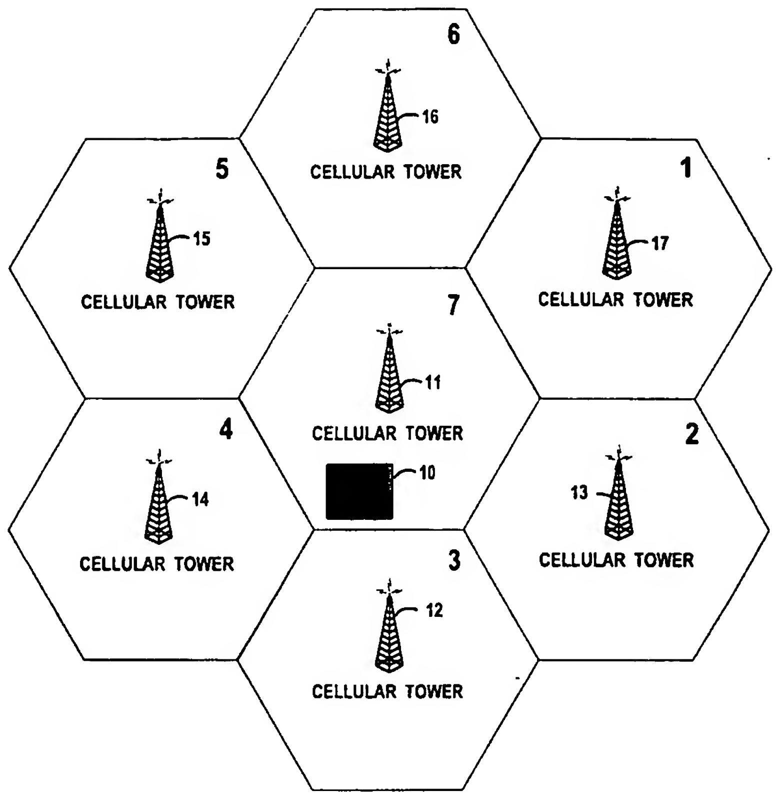
14. A method for locating mobile stations within a given area, said method comprising the steps of:

causing mobile stations entering said area to initiate a location update procedure; and

rejecting said location update request; and

reporting said location update attempt to a location server.

15. The method of claim 14, wherein causing location update is implemented by transmission of a phantom base station broadcast channel having a different LAI.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16
CELLULAR TOWER
5
15
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1
17
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7
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FIG. 1

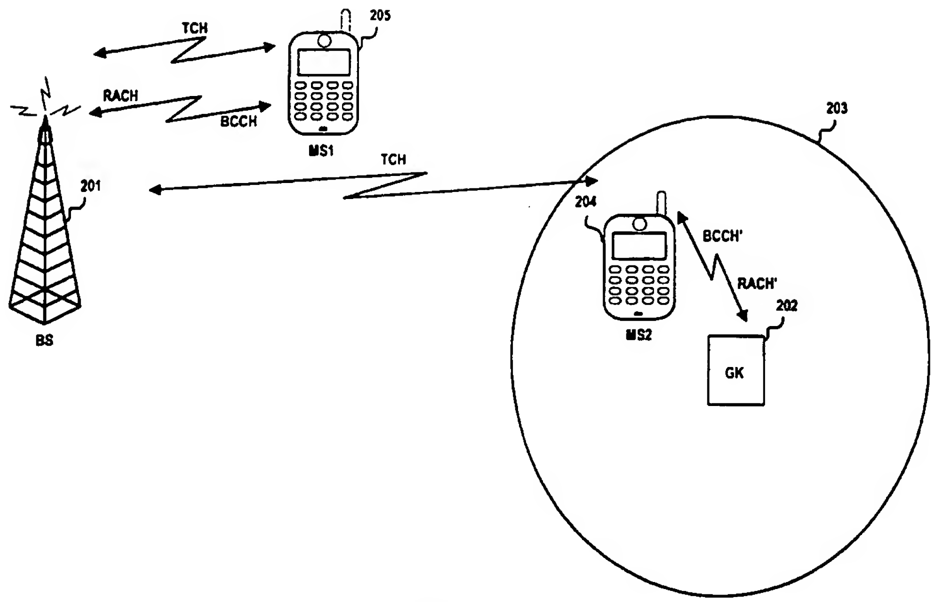
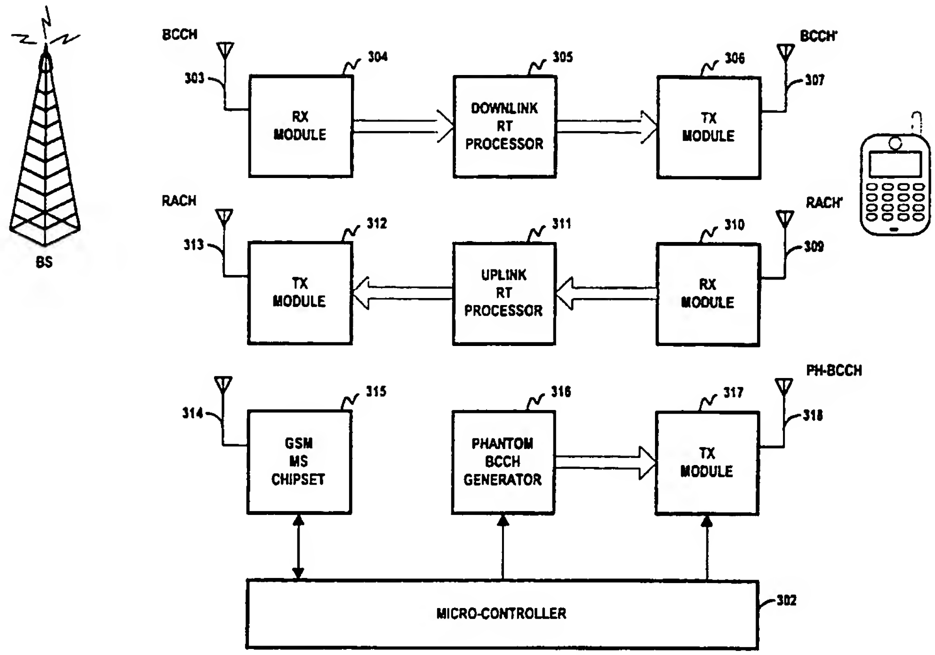


FIG. 2


BS
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RX MODULE
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DOWNLINK RT PROCESSOR
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TX MODULE
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311
UPLINK RT PROCESSOR
310
RX MODULE
RACH'
309
314
315
GSM MS CHIPSET
316
PHANTOM BCCH GENERATOR
317
TX MODULE
PH-BCCH
318
MICRO-CONTROLLER
302

FIG. 3

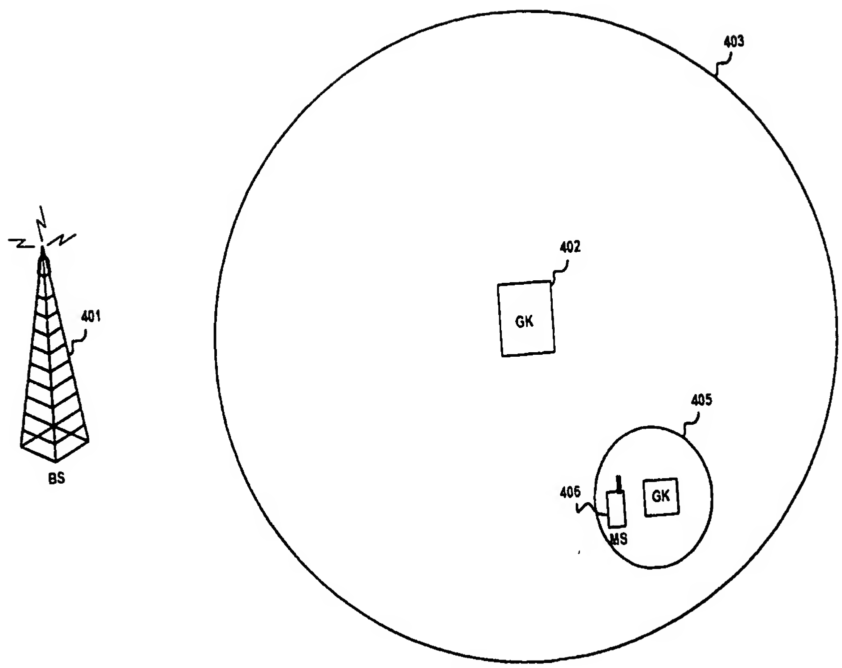

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL00/00236

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : H04B 1/38
US CL : 455/11.1, 456, 561
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

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U.S. : 455/11.1, 426, 445, 456, 457, 561

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,535,259 A (DENT et al) 09 July 1996 (09.07.1996), column 4, line 41 - column 5, line 39.	1-13
A	US 4,752,951 A (KONNEKER) 21 June 1988, column 1, lines 38-59, and column 3, lines 28-52	1-15
Y	US 5,598,459 A (HAARTSEN) 28 January 1997, column 7, lines 5-39.	1-15
Y	US 5,341,410 A (ARON et al) 23 August 1994, column 3, lines 1-66.	1-15
Y	US 5,493,286 A (GRUBE et al) 20 February 1996, column 2, line 63 - column 3, line 43.	1-13
A	US 5,422,930 A (McDONALD et al) 06 June 1995, column 1, line 57 - column 2, line 63.	1-15

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